

## REMARKS

### Status of the Claims

Claims 1-31, 33, 34 and 43-50 are pending. Claims 1, 13, 30, and 45 are amended for clarification purposes. For the convenience of the Examiner, the pending claims as amended herein are provided as Attachment B.

### Issues Under 35 U.S.C. § 112

Claims 1-3, 6-19, 22-34 and 45-50 are rejected under 35 U.S.C. § 112, second paragraph, as allegedly being indefinite. This rejection is respectfully traversed. Reconsideration and withdrawal thereof are requested.

The Office Action essentially repeats a rejection of record, stating that “it is still not clear what the components of the specific coating composition comprises which meet the characteristics of puncture resistance and flex crack resistance as stated in the claim.”

The Office Action further alleges, again in a repeated assertion, that the “claims merely [set] forth physical characteristics desired in an article, and [do not set] forth specific compositions which would meet such characteristics, [and] are invalid as vague, indefinite, and functional, since they cover any conceivable combination or ingredients either presently existing, or which might be discovered in the future and which would impart the desired characteristics.” The Office Action relies upon Ex parte Slob for support of this assertion.

Taking each issue in turn, Applicant first respectfully submits that the “[component] of the specific coating composition” that is allegedly unclear is a thermoplastic polyolefin

elastomer. For example, a feature of claim 1 is “a durability layer coated on at least one of said first or second side comprising of a thermoplastic polyolefin elastomer ...”.

It is abundantly clear that the coating composition comprises a thermoplastic polyolefin elastomer. This has been explained in numerous responses (see, for example, the responses filed September 3, 2002 and February 4, 2002) and in a personal interview August 14, 2002.

Thermoplastic polyolefin elastomers are known in the art and reasonably convey to one of ordinary skill in the art the metes and bounds of the invention. To comply with 35 U.S.C. § 112, second paragraph, the claims merely “reasonably convey” the invention to one of ordinary skill in the art. See, M.P.E.P. § 2173.02 entitled CLARITY & PRECISION. More precise claim language than what “reasonably” conveys is simply not required.

The following statements appear to be the basis for this rejection: (i) “‘TPO’ is not clear” and (ii) a “thermoplastic polyolefin elastomer ... is a species of TPO.” Applicant respectfully submits that both statements are erroneous. One of ordinary skill in the art understands that “TPO” is known as thermoplastic polyolefin elastomer. This has been explained in numerous responses to the Office Actions and numerous documents provided by Applicant as supplements to the Responses.

For example, on page 1 of Attachment A to Response filed February 4, 2002, is a document from Chemical Market Resources. And that document states as follows:

Thermoplastic polyolefin elastomers (TPOs) are compounds comprising blends of thermoplastics such as polypropylene (PP) and elastomers such as ethylene-rubber (EPM) or EP(D)M rubber...

TPOs are defined as a blend of thermoplastic and elastomeric phases where the elastomeric content is more than 20% by weight. In recent years, TPOs have gained increasing acceptance over other computing materials because of the

global trend toward homogenization of materials usage in automobile interior and exterior applications.

Thus, it clear that "TPOs" are understood. Further, it is clear that thermoplastic polyolefin elastomers are "TPOs", not a "species of TPO" as alleged by the Examiner.

Other than the conclusory allegation that the term "TPO" is not clear, the office action is silent as to why one of ordinary skill in the art would not understand the term.

Furthermore, to further emphasize the "reasonably precise" language of the present claims and the fact that thermoplastic polyolefin elastomers are understood in the art, the Examiner's attention is respectfully directed to the following US Patents:

US Patent No. 6,120,714 to Allan, et al. See column 7 lines 9 through 50 where Allan lists the thermoplastic resins preferably used in his invention: "The thermoplastic resin preferably used includes only resins which are generally referred to as thermoplastic resins, for example, ... thermoplastic elastomers such as polyolefin elastomer (TPU) thermoplastic styrene butadiene elastomer (SBC), thermoplastic polyolefin elastomer (TPO), thermoplastic polyester elastomer (TPEE), thermoplastic vinylchloride elastomer (TPVC), thermoplastic polyamide elastomer (TPA-E) and the like; etc."

US Patent No. 6,376,077 to Hiraishi, et al. See column 5 line 30: "when inorganic particles treated with an amino-containing silane coupling agent or a mercapto-containing silane coupling agent are used for a TPO (thermoplastic polyolefin elastomer) – based resin, high values are maintained in both of tensile strength and elongation.

US Patent No. 5,849,820 to Kim, et al. See Table 16 at column 17 where certain examples have a resin TPO. Below the table the following is stated: "TPO: thermoplastic polyolefin elastomer."

US Patent No. 5,718,954 to Sano, et al. See examples 35 and 36 at column 31. In these examples, molding products were obtained in the same way as in Example 33 "except that a thermoplastic polyolefin elastomer (TPO) was used in lieu of L-LDPE."

US Patent No. 5,714,227. See claim 5 which states: "The interior molded article for automobiles is claimed in claim 2, where it is said thermoplastic elastomer has a hardness according to JIS K 6301 A of 10° to 60°, and comprises, as an essential

ingredient, a polyolefin elastomer (TPU) a thermoplastic polystyrene elastomer (TPS) or a thermoplastic polyolefin elastomer (TPO), and the ratio of TPS to TPO by weight thereof is from 10/90 to 50/50.”

Based on Applicant’s repeated arguments, supporting documents previously cited, and the US Patents referenced above (one of which includes the identical claim language objected to by the Examiner) Applicant respectfully submits that the instant claims clearly comply with 35 U.S.C § 112.

Notwithstanding, the above amendment removes the term “TPO” from the claim.

Accordingly, Applicants respectfully submit that the claims are clearly in condition for allowance.

Complete Response to Applicant’s Arguments Requested

MPEP Section 707.07(f) states that “where an applicant traverses any rejection, the Examiner should, if he or she repeats the rejection, take note of the Applicant’s argument and answer the substance of it.”

In the instant application, the Examiner has offered a practically verbatim repetition of the same arguments for at least three consecutive Office Actions and states that the subsequent traversals of Applicant “have been considered but are not persuasive.” No further specificity is offered. Applicants respectfully submit that this does not comply with the guidelines set forth in the MPEP.

Since the Office Actions are silent with respect to Attachment A discussed above (cited to show that the terminology of the instant application is well known in the art), Applicant is not

sure if it was even considered by the Examiner. In the event that it was not, or was separated from the file, attached is another copy.

Additionally, in the response submitted September 3, 2002, Applicants provide four distinct reasons why Ex parte Slob, a 1967 Board of Appeals decision, does not apply to the pending claims. Each of these reasons have been ignored in the outstanding Office Action.

For example, in order to rely upon Ex parte Slob, the Examiner must equate the claim language of “liquifiable substance” with the present durability barrier layer that comprises a thermoplastic polyolefin elastomer. As should be clear from the record, the claim thermoplastic polyolefin elastomer is stated more in terms of a composition than being purely functional (i.e., liquifiable substance).

Additionally, to rely upon Ex parte Slob, the Examiner must equate claim language that the Board of Appeals said covered “anything which would perform the desired results” with the thermoplastic polyolefin elastomers of the present invention. In Slob, both the Examiner and the Board cited liquifiable substances that could not be used with the detergent and compositions claimed by Slob. Further, the Board stated that the claims were “drawn to all substances which are totally unrelated to those ingredients shown as suitable by appellant and which are merely claimed by the designation of desired properties” (liquifiable). In the instant case, no examples whatsoever are set forth in the Office Action that show thermoplastic polyolefin elastomers which cannot be used with the present invention or those which are unsuitable, but have the claimed properties (thermoplastic polyolefin elastomers).

Issues Under 35 U.S.C. § 102(b)

Claims 1-3, 6-19, 22-34, and 43-50 are rejected under 35 U.S.C. § 102(b) as being allegedly anticipated by Langley, U.S. Patent No. 5,948,708. This rejection is respectfully traversed. Reconsideration and withdrawal are requested.

As Applicant has previously stated in the record, the cited reference fails to disclose a chemical barrier fabric comprising a thermoplastic polyolefin elastomer (TPO). The present invention comprises a thermoplastic polyolefin elastomer on at least one side of a multiple layer, chemical barrier material.

The assertions of the Office Action appear to be based upon an erroneous interpretation of TPO and/or thermoplastic polyolefin elastomers. For example, see page 4 of the Office Action, which states: "...which are thermoplastic polyolefin, TPO." In view of the information set forth in the record and above, it is clear that TPOs are not generic to thermoplastic polyolefins.

Nonetheless, the term "TPO" is removed from the claim in the above amendment.

In view of the differences outlined above, and previously in the record, Applicant respectfully submits that the cited reference fails to disclose an identical invention as claimed, as required under 35 U.S.C. § 102. Richardson v. Suzuki Motor Co., 9 U.S.P.Q.2d 1913, 1920 (Fed. Cir. 1989).

Accordingly, this rejection should be withdrawn.

Claims 1-31, 33, 34, and 43-50 are rejected under 35 U.S.C. § 102(b) as being allegedly anticipated by Hauer, et al., U.S. Patent No. 5,626,947. This rejection is respectfully traversed. Reconsideration and withdrawal thereof are requested.

Like the above, this rejection appears to be based on the erroneous interpretation of TPO and/or thermoplastic polyolefin elastomers. For example, on pages 6 and 7 of the Office Action:

- (i) “applicant’s claims are broader, namely directed to the genus of TPO and not the species of TOP, i.e., thermoplastic polyolefin elastomer...”,
- (ii) “applicant’s arguments regarding TPO are noted but TPO is a genus not TPOE, thermoplastic polyolefin elastomer, a species...”, and
- (iii) “Applicant is arguing elastomer with TPO as a species and the claims are directed to TPO as a genus.”

Again, it is clear from the record, including above, that one of ordinary skill in the art associates TPO with thermoplastic polyolefin elastomers.

Nonetheless, the term TPO has been removed from the claim language as stated above. That alone should remove the remaining issues with respect to this reference, and it should be clear that the Hauer et al. is not anticipatory of the present invention.

In addition to being non-anticipatory, Hauer et al. does not render the present invention obvious. In the Office Action of May 22, 2001, Hauer et al. was the basis of an obviousness rejection. In the subsequent Response (August 22, 2001) Applicants submitted a Declaration showing superior and unexpected results of the present invention when its performance was

compared to Hauer et al. In the next Office Action, the Declaration and obviousness arguments were not addressed. The obviousness rejection was withdrawn and replaced with a rejection based on 35 U.S.C. § 102.

#### Interview of August 14, 2002

As stated in a previous response, a personal interview was conducted on August 14, 2002. Participating were the Examiner, his Supervisory Patent Examiner, Applicant, and Applicant's representative.

The Examiner Interview Summary Form states that an agreement was reached. Specifically, it was agreed that "if elastomer [sic] added to the claims then this would overcome the prior art of record."

Applicants note that in the Amendment filed following the interview, "elastomer" was added to the claims. Such language remains after the present amendment.

#### Petition for an Extension of Time

Pursuant to the provisions of 37 C.F.R. §§ 1.17 and 1.136(a), Applicant hereby petitions for an extension of two months to May 5, 2003 (Monday) for the period in which to file a response to the outstanding Office Action. The required fee of \$410.00 is attached hereto.

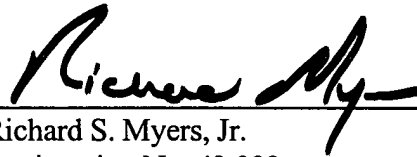
#### Conclusion

From the foregoing, further and favorable reconsideration in the form of a Notice of Allowance is in order and such action is earnestly solicited.



If the Examiner has any questions concerning this Amendment or the Application in general, he is respectfully urged to contact Richard S. Myers, Jr. (Reg. No. 42,022) at the number listed below.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "Richard S. Myers, Jr.", is written over a horizontal line.

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ATTORNEY FOR APPLICANT

Version With Markings to Show Claim Changes Made

Claim 1 (Seven Times Amended). A composite chemical barrier fabric having improved durability comprising:

a multiple layer, chemical barrier material having a first side and a second side; and  
a durability barrier layer coated on at least one of said first or second side comprising a thermoplastic polyolefin elastomer [(TPO)] with an inherent bonding affinity to the chemical barrier material, the coated chemical barrier composite achieving at least 25% improvement in ASTM 1342 puncture resistance and at least 25% improvement in modified ISO 7854 Method B flex-crack resistance of the fabric when compared to a fabric not having said durability barrier layer.

Claim 13 (Five Times Amended). A composite chemical barrier fabric having improved durability, comprising:

a multiple layer, chemical barrier material having a first side and a second side; and  
a durability barrier layer coated on at least one of said first or second side comprising a layer of a thermoplastic polyolefin elastomer [(TPO)] having an inherent bonding affinity to the chemical barrier material, the resin having an ASTM D1238 melt flow rate 230/2.16g/10 min of about 0.45; an ASTM D793 density at 23 degrees Celsius g/cm<sup>3</sup> of about 0.88; and an ASTM D1693 environmental stress-cracking resistance, hours of about >3,000.

Claim 30 (Three Times Amended). A composite chemical barrier fabric having improved durability comprising:

a multiple layer, chemical barrier material having a first side and a second side; and  
a durability barrier layer coated on at least one of said first or second side comprising a thermoplastic polyolefin elastomer resin [(TPO)] having an inherent bonding affinity to the chemical barrier material, the resin having an ASTM D1238 melt flow rate 230/2.16g/10 min of about 0.45.

Claim 45 (Amended). A composite chemical barrier fabric having improved durability, comprising:

a multiple layer, chemical barrier material having a first side and a second side; and  
a durability barrier layer coated on at least one of said first or second side comprising a layer of a thermoplastic polyolefin elastomer resin [(TPO)] having an inherent bonding affinity to the chemical barrier material, the resin having an ASTM D793 density at 23°C g/cm<sup>3</sup> of about 0.88.

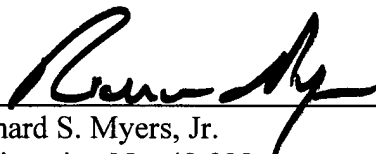
Page 3

CERTIFICATE OF FIRST CLASS MAILING

I hereby certify that this Small Entity Transmittal Form and enclosures (Amendment Under 37 C.F.R. § 1.111, Attachment A (19 pages), Attachment B (7 pages), PTO-2038 Form in the amount of \$410.00, and Return Receipt Postcard are being deposited with the United States Postal Service as first class mail in an envelope addressed to:

Mail Stop Amendment - Fee  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

on May 5, 2003 (Monday).

  
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*Part of Paper #28*

## ATTACHMENT B - PENDING CLAIMS

(As Amended in the Amendment Filed May 5, 2003)

Applicant: CARROLL, Todd R.  
Serial No: 09/128,721  
Filed: August 4, 1998  
For: Composite Chemical Barrier Fabric with Enhanced Durability  
Examiner: GUARRIELLO, John J.  
Group Art Unit: 1771  
Attorney's Docket No: 11632N.020880  
Customer No: 32885

Claim 1. A composite chemical barrier fabric having improved durability comprising:  
a multiple layer, chemical barrier material having a first side and a second side; and  
a durability barrier layer coated on at least one of said first or second side comprising a  
thermoplastic polyolefin elastomer with an inherent bonding affinity to the chemical barrier  
material, the coated chemical barrier composite achieving at least 25% improvement in ASTM  
1342 puncture resistance and at least 25% improvement in modified ISO 7854 Method B flex-crack  
resistance of the fabric when compared to a fabric not having said durability barrier layer.

Claim 2. The composite chemical barrier fabric of claim 1, wherein the multiple layer chemical barrier material contains at least one stratum that comprises a material selected from the group consisting of polyvinylidene chloride, ethylene vinyl acetate, ethylene vinyl alcohol, nylon, polyvinyl alcohol, polyester, polytetrafluoroethylene, fluorinated ethylene propylene, polyvinylidene chloride copolymer, acrylic, acrylonitrile copolymer, ionomers, ethylene/methacrylate acid copolymer, polybutylene, metalized polyester, polypropylene, oriented polypropylene, and polyamide.

Claim 3. The composite chemical barrier fabric according to Claim 2, wherein the multiple layer, chemical barrier material has one or more exposed surfaces that comprises a material selected from the group consisting of polyethylene, ethylene ethyl acrylate, ethylene methyl acrylate, ethylene vinyl acetate, ethylene vinyl acetate copolymer, and polypropylene.

Claim 4. The composite chemical barrier fabric of Claim 3 wherein the thermoplastic polyolefin coating has a thickness greater than 1 mil.

Claim 5. The composite chemical barrier fabric of Claim 4 wherein the thermoplastic polyolefin coating has a more specific thickness of at least about 1 mils to about 10 mils.

Claim 6. The composite chemical barrier fabric of Claim 3 wherein the thermoplastic polyolefin is in the form of a free film and is laminated to one or more of the exposed surfaces of the chemical barrier, multiple film composition.

Claim 7. The composite chemical barrier fabric of Claim 1, wherein the fabric is configured into items of protective clothing selected from the group consisting of suits, zippers, gloves, hoods, and shoe covers.

Claim 8. The composite chemical barrier fabric of Claim 1, further comprising seams that are sealed using hot air welding.

Claim 9. The composite chemical barrier fabric of Claim 1, wherein the fabric is slit to a narrow width for use as a seam sealing tape.

Claim 10. The composite chemical barrier fabric of Claim 1 wherein the fabric is slit to a narrow width and used as an interfacing material in combination with PVC and PVC/CPE alloy fabrics to create gas-tight unions between PVC visors and PVC zippers.

Claim 11 The composite chemical barrier fabric of Claim 1 wherein the fabric is a coextruded multi-layered chemical barrier with one or more exterior layers of thermoplastic polyolefin.

Claim 12. The composite chemical barrier fabric of Claim 1, wherein the thermoplastic polyolefin film comprises polypropylene.

Claim 13. A composite chemical barrier fabric having improved durability, comprising:  
a multiple layer, chemical barrier material having a first side and a second side; and  
a durability barrier layer coated on at least one of said first or second side comprising a layer of a thermoplastic polyolefin elastomer having an inherent bonding affinity to the chemical barrier material, the resin having an ASTM D1238 melt flow rate 230/2.16g/10 min of about 0.45; an ASTM D793 density at 23 degrees Celsius g/cm<sup>3</sup> of about 0.88; and an ASTM D1693 environmental stress-cracking resistance, hours of about >3,000.

Claim 14. The composite chemical barrier fabric of Claim 13 wherein the resin is comprised substantially of polypropylene.

Claim 15. The composite chemical barrier fabric according to Claim 13, wherein the resin comprises polypropylene copolymers, polyethylene, or polyethylene copolymers.

Claim 16. The composite chemical barrier fabric according to Claim 13, wherein the resin is comprised of blends of polypropylene and polyethylene.

Claim 17. The composite chemical barrier fabric according to Claim 13, wherein the resin is comprised of a majority of polypropylene mixed with other thermoplastic olefin resins.

Claim 18. The composite chemical barrier fabric of claim 13, wherein the multiple layer chemical barrier material contains at least one stratum that comprises a material selected from the group consisting of polyvinylidene chloride, ethylene vinyl acetate, ethylene vinyl alcohol, nylon, polyvinyl alcohol, polyester, polytetrafluoroethylene, fluorinated ethylene propylene, polyvinylidene chloride copolymer, acrylic, acrylonitrile copolymer, ionomers, ethylene/methacrylate acid copolymer, polybutylene, metalized polyester, polypropylene, oriented polypropylene, and polyamide.

Claim 19. The composite chemical barrier fabric according to Claim 18, wherein the multiple layer, chemical barrier material has one or more exposed surfaces that comprises a material selected from the group consisting of polyethylene, ethylene ethyl acrylate, ethylene methyl acrylate, ethylene vinyl acetate, ethylene vinyl acetate copolymer, or polypropylene.

Claim 20. The composite chemical barrier fabric of Claim 19 wherein the thermoplastic olefin coating has a thickness greater than 1 mil.

Claim 21. The composite chemical barrier fabric of Claim 19 wherein the thermoplastic olefin coating has a thickness of between 1 mil and 10 mils.

Claim 22. The composite chemical barrier fabric of Claim 13 wherein the thermoplastic olefin is in the form of a free film and subsequently laminated to one or more of the exposed surfaces of the chemical barrier, multiple film composition.



Claim 23. The composite chemical barrier fabric of Claim 13 wherein the modified ISO 7854 Method B flex crack resistance of the fabric is enhanced by at least 25% through the combination of a multi-layered chemical barrier film and the added layer of thermoplastic olefin resin.

Claim 24. The composite chemical barrier fabric of Claim 13 wherein the ASTM 1342 puncture resistance of the fabric is enhanced by at least 25% through the combination of a multi-layered chemical barrier film and the added layer of thermoplastic olefin resin.

Claim 25. The composite chemical barrier fabric of Claim 13 wherein the fabric is sealable using hot air welding.

Claim 26. The composite chemical barrier fabric of Claim 1, wherein the multiple layer chemical barrier material contains at least one stratum that comprises a material selected from the group consisting of polyolefin, polyolefin copolymers, ionomers and ionomer copolymers.

Claim 27 The composite chemical barrier fabric of Claim 1, wherein the multiple layer chemical barrier material has one or more exposed surfaces that comprise a material selected from the group consisting of polyolefin, polyolefin copolymers, ionomers, and ionomer copolymers.

Claim 28. The composite chemical barrier fabric of Claim 13, wherein the multiple layer chemical barrier material contains at least one stratum that comprises a material selected from the group consisting of polyolefin, polyolefin copolymers, ionomers and ionomer copolymers.

Claim 29. The composite chemical barrier fabric of Claim 13, wherein the multiple layer, chemical barrier material has one or more exposed surfaces that comprises a material selected from the group consisting of polyolefin, polyolefin copolymers, ionomers, and ionomer copolymers.

Claim 30. A composite chemical barrier fabric having improved durability comprising:  
a multiple layer, chemical barrier material having a first side and a second side; and  
a durability barrier layer coated on at least one of said first or second side comprising a thermoplastic polyolefin elastomer resin having an inherent bonding affinity to the chemical barrier material, the resin having an ASTM D1238 melt flow rate 230/2.16g/10 min of about 0.45.

Claim 31. The composite chemical barrier fabric of claim 30, wherein the multiple layer chemical barrier material contains at least one stratum that comprises a material selected from the group consisting of polyvinylidene chloride, ethylene vinyl acetate, ethylene vinyl alcohol, nylon, polyvinyl alcohol, polyester, polytetrafluoroethylene, fluorinated ethylene propylene, polyvinylidene chloride copolymer, acrylic, acrylonitrile copolymer, ionomers, ethylene/methacrylate acid copolymer, polybutylene, metalized polyester, polypropylene, oriented polypropylene, and polyamide.

Claim 33. The composite chemical barrier fabric of Claim 30, wherein said thermoplastic polyolefin resin has an ASTM D793 density at 23 degrees celsius g/cm<sup>3</sup> of about 0.88.

Claim 34. The composite chemical barrier fabric of Claim 30, further comprising seams that are sealed using hot air welding.

Claim 43. The composite chemical barrier fabric of Claim 30, wherein the fabric achieves at least about a 25% improvement in ASTM 1342 puncture resistance compared to a fabric without the durability layer.

Claim 44. The composite chemical barrier fabric of Claim 30, wherein the fabric achieves at least about a 25% improvement in modified ISO 7854 Method B flex crack resistance compared to a fabric without the durability layer.

Claim 45. A composite chemical barrier fabric having improved durability, comprising:  
a multiple layer, chemical barrier material having a first side and a second side; and  
a durability barrier layer coated on at least one of said first or second side comprising a layer of a thermoplastic polyolefin elastomer resin having an inherent bonding affinity to the chemical barrier material, the resin having an ASTM D793 density at 23°C g/cm<sup>3</sup> of about 0.88.

Claim 46. The composite chemical barrier fabric of claim 45, wherein the multiple layer chemical barrier material contains at least one stratum that comprises a material selected from the group consisting of polyvinylidene chloride, ethylene vinyl acetate, ethylene vinyl alcohol, nylon, polyvinyl alcohol, polyester, polytetrafluoroethylene, fluorinated ethylene propylene, polyvinylidene chloride copolymer, acrylic, acrylonitrile copolymer, ionomers, ethylene/methacrylate acid copolymer, polybutylene, metalized polyester, polypropylene, oriented polypropylene, and polyamide.

Claim 47. The composite chemical barrier fabric of Claim 45, wherein the fabric achieves at least about a 25% improvement in ASTM 1342 puncture resistance compared to a fabric without the durability layer.

Claim 48. The composite chemical barrier fabric of Claim 45, wherein the fabric achieves at least about a 25% improvement in modified ISO 7854 Method B flex crack resistance compared to a fabric without the durability layer.

Claim 49. The composite chemical barrier of Claim 45, wherein the TPO comprises polypropylene.

Claim 50. The composite chemical barrier of Claim 45, wherein the durability barrier layer has a thickness of about 1 mil to 10 mils.



# Chemical Market Resources

## *Multi-Client Studies*

### **Thermoplastic Polyolefin Elastomers, Markets, Technologies & Trends, 1999-2004**

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#### Corporate Profile

#### Single-Client Studies

#### Multi-Client Studies

#### New Generation Polyolefins

#### FlexPO 2002

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#### Related Links

Chemical Market Resources, Inc. (CMR) announces the release of their newest multiclient study, ***Thermoplastic Polyolefin Elastomers, Markets, Technologies & Trends, 1999-2004***. The report provides an in-depth market and end-use economics study of the TPO/TPV market in North America, Europe and Japan.

Thermoplastic polyolefin elastomers (TPOs) are compounds comprising blends of thermoplastics such as polypropylene (PP) and elastomers such as ethylene-propylene rubber (EPM) or EP(D)M rubber. The rubber phase is finely dispersed within the continuous thermoplastic phase. TPOs have performance properties equivalent to conventional thermoset rubbers and process as efficiently as thermoplastics.

The five major types of TPOs include (1) physical blends (PHY-TPO), (2) thermoplastic vulcanizates (TPV), (3) reactor-made (REC-TPO), (4) melt processible rubbers and (5) soft TPOs (subset of physical blends, TPVs and reactor blends). CMR's new study presents a general comparison among the different types of TPOs as well as a multi-attribute analysis for the different types of TPOs comparing their performance properties.

TPOs are defined as a blend of thermoplastic and elastomeric phases where the elastomeric content is more than 20% by weight. In recent years, TPOs have gained increasing acceptance over other competing materials because of the global trend towards homogenization of materials usage in automotive interior and exterior applications.

Thermoplastic polyolefin elastomers have gained an edge over most thermoset rubbers because they provide faster molding cycles, lower energy consumption, closer tolerances on fabricated parts and lighter weight, and the scrap generated during processing and fabrication is recycled or reused. The recent trend towards the reduction

ATTACHMENT A

of the number of types of plastics used in automobiles for recycling purposes has accelerated development of TPOs.

In the past five years, TPOs have gained attention because of the following reasons: (1) recent developments in metallocene-catalyzed plastomers/elastomers based TPO formulations, (2) intermaterial competition among different types of TPOs and other materials, (3) developments in reactor-made TPOs and (4) development of soft TPOs that are used in applications such as roofing membranes, specialty films and others.

The major end-use markets for thermoplastic elastomeric polyolefins include 1) automotive, 2) molded goods, 3) roofing membranes, 4) wire and cable, 5) hoses and tubing, 6) medical, 7) specialty films and 8) grips. The report features 1999 demand for each end use and projects demand for 2004, separating out the data by each of the major types of material - TPOs, TPVs and plastomers/elastomers. According to the study, overall demand for thermoplastic polyolefin elastomers in North America is expected to grow at an average annual rate of 7.9%.

The study includes research on each of the technologies currently used for manufacturing TPO/TPV; a discussion on the impact of metallocene-catalyzed plastomers/elastomers; manufacturing cost analysis derived through a modular approach; and an analysis of growth drivers in the industry. Major producers are identified and profiled as well as raw material suppliers to the thermoplastic polyolefin elastomer industry. The study provides a unique perspective of the industry by identifying material requirements for major end-uses.

Also of interest, the study includes research on soft TPOs - a relatively new breed of product with excellent market potential. Soft TPOs are a subset of physical blends, TPVs and reactor made TPOs having flexural moduli ranging from 1,500 psi to 50,000 psi. These are essentially low flexural modulus materials that are used in end-use applications such as: (1) roofing membranes, (2) automotive under-the-hood applications, (3) automotive cover skins, (4) molded goods, (5) wire and cable, (6) gaskets and sealants, (7) hoses and tubing and others. Soft TPOs have gained popularity in the last two years because they have been able to expand the application horizon of

TPOs beyond automotive applications. The 1999 demand for soft TPOs in North America alone was 180 million pounds, which represents 36 MM lbs. of physical blends, 101 MM lbs. of vulcanized TPOs, and 43 MM lbs. of reactor made TPOs. These numbers are further broken down by market in the report.

Research findings conclude that roofing membranes are expected to be a high growth area for soft TPOs in North America. Other significant growth areas include soft touch grips, specialty films and some newer applications. He suggests that manufacturers of TPOs that have largely focused on automotive end-use applications should consider diversifying their product line in order to accommodate newer soft TPO applications – thus enjoying the very high growth rate levels of the past.

Published in English in December, 2000. Contains 200 pages. Price is 8,500 US dollars. An abbreviated Table of Contents follows:

Chapter 1: Executive Summary  
Chapter 2: Introduction  
Chapter 3: Technologies of TPOs  
Chapter 4: North American Demand for TPOs  
Chapter 5: North American Suppliers of TPOs  
Chapter 6: European Supply and Demand  
Chapter 7: Japanese and Rest of the World Supply and Demand  
Chapter 8: Impact of Metallocene Catalyzed Plastomers/Elastomers  
Chapter 9: Strategic Analysis

Key Exhibits: Available upon request

**For further information contact Chemical Market Resources, Inc., at [cmrinfo@cmrhoutex.com](mailto:cmrinfo@cmrhoutex.com). or 281-333-3313 in Houston, Texas.**

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For additional information, comments, or questions, please contact us at [cmrinfo@cmrhoutex.com](mailto:cmrinfo@cmrhoutex.com).



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## Knowledge Foundation Conference: Novel Commercial Breakthroughs in Thermoplastic Elastomers

### Novel Commercial Breakthroughs in Thermoplastic Elastomers

June 28-29, 1999 ~ The Drake Hotel ~ Chicago, IL, USA

[ [Background](#) | [Agenda](#) | [Participants](#) | [Register](#) ]

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The emergence of two new classes of TPEs -- Polyolefin Block & Graft Copolymers and Reactor-made Thermoplastic Polyolefin -- coupled with dramatically improved means of controlled synthesis (metallocene-catalyzed polymerization) have opened up a wider range of commercial applications than ever thought possible. This intensive conference is one of the few meetings designed to address the potential of TPEs from a materials perspective. More specifically, you will benefit from the carefully chosen pool of commercial and academic speakers who will provide you with the latest advancements on physical properties, morphology, polymer structure as well as an exclusive examination of adhesion and TPE materials. These findings can be leveraged to furnish even more cost effective alternatives for plastic and rubber applications.

#### This Conference Will

- Examine metallocene catalyzed and other new classes of TPEs as potential replacements for both plastic & rubber applications
- Provide in-depth focus on both emerging materials as well as enhancements to traditional materials
- Present sessions to compare advantages and limitations of various TPEs in specific applications
- Plus, panel discussion addressing an important issue for the novel application: Adhesion of TPEs to Rigid Substrates

This conference is not just another "user handbook", but an in-depth analysis of new opportunities. Hear the most up-to-date advances from industry leaders such as DSM Thermoplastics, BASF Corporation, Dugussa-Huls AG Engineering Plastics, ARDL Plastic Testing Division, Advanced Polymer Alloys and Optatech Corporation.

#### Materials Discovery

- Graft copolymers prepared by the combination of metallocene catalysts
- Reactor-made thermoplastic polyolefin elastomers
- Fracture toughness characterization of the thermoplastic polyolefin elastomer
- Rheological behaviors of (meth)acrylate thermoplastic elastomers

#### Recent Advances in TPEs

- Extrusion of low density chemically foamed thermoplastic vulcanizates
- Structure-property relationships of styrenic TPEs
- Advancements made in TPE bondability

#### Applications

- Advantages of TPEs for medical applications
- High performance TPE for high performance applications
- A new and unique TPV concept for oil resistant applications

If you are an end-user, producer or supplier, you cannot afford to miss this interdisciplinary event. Space is limited, so please be sure to **REGISTER TODAY!**

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### CONFERENCE AGENDA

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**MONDAY, JUNE 28, 1999**

8:00 *Registration, Coffee and Danish*

1:00 *Luncheon*

9:00 **Chairperson's Opening Remarks**  
Geoffrey Holden

2:30 **Fracture Toughness  
Characterization of Thermoplastic  
Polyolefin Elastomers**  
Chang-Sik Ha

#### MATERIALS DISCOVERY SESSION

9:05 **Reactor-Made Thermoplastic  
Polyolefin Elastomers**  
Rino Messere

3:05 **Morphology Determination  
of Novel Thermoplastic  
Elastomers with WAXD, SAXS and  
TEM**  
Shinzo Kohiji

9:40 **New Polyolefin Block and Graft  
Copolymers Prepared by the Combination  
of Metallocene Catalysts, Chain Transfer  
Agents and Reactive Comonomers**  
T. C. (Mike) Chung

3:40 *Refreshment Break & Exhibit  
Viewing*

10:15 **Isobutenic Block Copolymer TPEs;  
Comparison of Synthetic Approaches**  
Rudolf Faust

#### ADVANCES IN TPE MATERIAL SESSION

3:55 **Styrenic Thermoplastic  
Elastomers**  
Geoffrey Holden

10:50 *Refreshment Break & Exhibit Viewing*

11:10 **Thermoplastic Elastomers Based on**

4:30 **Extrusion of Low Density**



**Fully (Meth)acrylate Block Copolymers**  
Jiangdong Tong

**11:45 Anisotropy in Thermoplastic Elastomers**  
Barbara J. Gedeon

**12:20 Characterization of The Domain Structure in Thermoplastic Elastomer Materials Using Scattering Methods**  
Norbert Striebeck

**Chemically Foamed Thermoplastic Vulcanizates**  
Ryszard Brzowski

5:05 *Cocktail Reception/Cash Bar*

6:30 *Close of Day One*

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**TUESDAY JUNE 29, 1999**

8:00 *Exhibit Viewing, Coffee and Danish*

9:00 **Chairperson's Remarks**  
Geoffrey Holden

**APPLICATIONS SESSION**

9:05 **Materials and Techniques for Overmolding to Rigid Substrates**  
Paul Zwick

9:40 **Polyetherblockamides - High Performance TPE for High Performance Applications**  
Jörg Lohmar

10:15 **Medical Applications of Thermoplastic Elastomers**  
Joel Williams

10:50 *Refreshment Break & Poster Viewing*

11:20 **Design Considerations for Effective TPE Adhesion to Substrates**  
Rob Banning

11:55 **BASF Develops New Product Line for Blown and Cast Film Applications**  
Paul David Bury

12:30 **PARCEL -- A New and Unique TPV Concept for Oil Resistant Applications**  
Christer Bergström

1:05 **Panel Discussion:**  
Adhesion of TPE Materials to Rigid Substrates

**Moderator:**  
Paul Zwick

**Panelists:**  
Rob Banning  
Ryszard Brzowski  
Paul David Bury  
Joel Williams

1:30 *End of Conference*

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**PARTICIPATING ORGANIZATIONS**

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Advanced Polymer AlloysARDL, Plastic Testing  
Division

BASF Corporation

Degussa-Höls AG, Engineering Plastics

DSM TPE Inc.

Holden Polymer Consulting, Inc.

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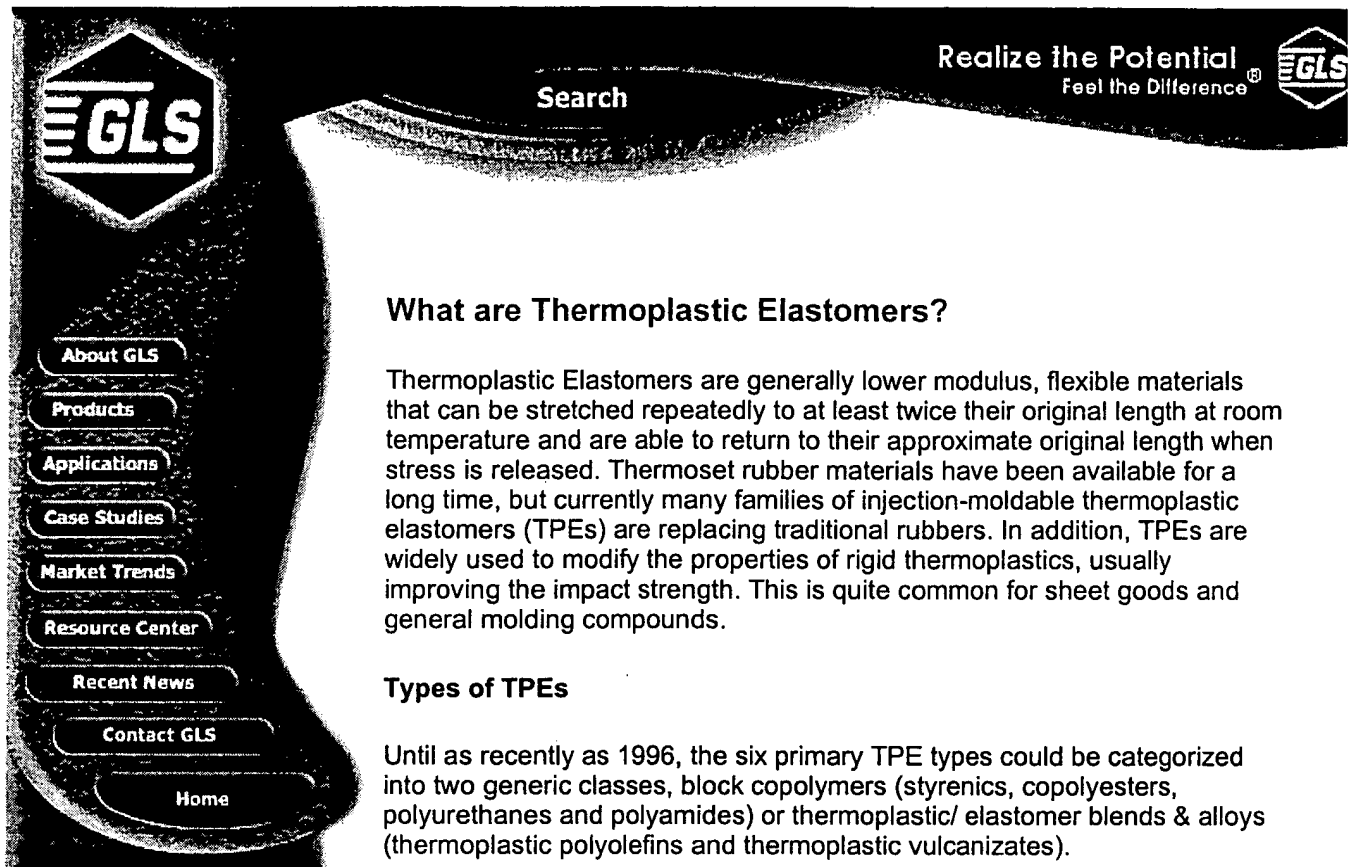
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## What are Thermoplastic Elastomers?

Thermoplastic Elastomers are generally lower modulus, flexible materials that can be stretched repeatedly to at least twice their original length at room temperature and are able to return to their approximate original length when stress is released. Thermoset rubber materials have been available for a long time, but currently many families of injection-moldable thermoplastic elastomers (TPEs) are replacing traditional rubbers. In addition, TPEs are widely used to modify the properties of rigid thermoplastics, usually improving the impact strength. This is quite common for sheet goods and general molding compounds.

### Types of TPEs

Until as recently as 1996, the six primary TPE types could be categorized into two generic classes, block copolymers (styrenics, copolyesters, polyurethanes and polyamides) or thermoplastic/ elastomer blends & alloys (thermoplastic polyolefins and thermoplastic vulcanizates).

These traditional TPE types are known as two-phase systems. Essentially, a hard thermoplastic phase is coupled mechanically or chemically with a soft elastomer phase, resulting in a TPE that has the combined properties of the two phases.

### Traditional TPE Classes

- Styrenics (S-TPE's)
- Copolyesters (COPE's)
- Polyurethanes (TPU's)
- Polyamides (PEBA's)
- Polyolefin Blends (TPO's)
- Polyolefin Alloys (TPV's)

### The many classes of Thermoplastic Elastomers

In addition to the two-phase TPEs, two new technologies have emerged. They are the *metallocene-catalyzed polyolefin plastomers & elastomers*, and *reactor-made thermoplastic polyolefin elastomers*.

### New TPE Entrants

- Reactor TPO's (R-TPO's)
- Polyolefin Plastomers (POP's)
- Polyolefin Elastomers (POE's)

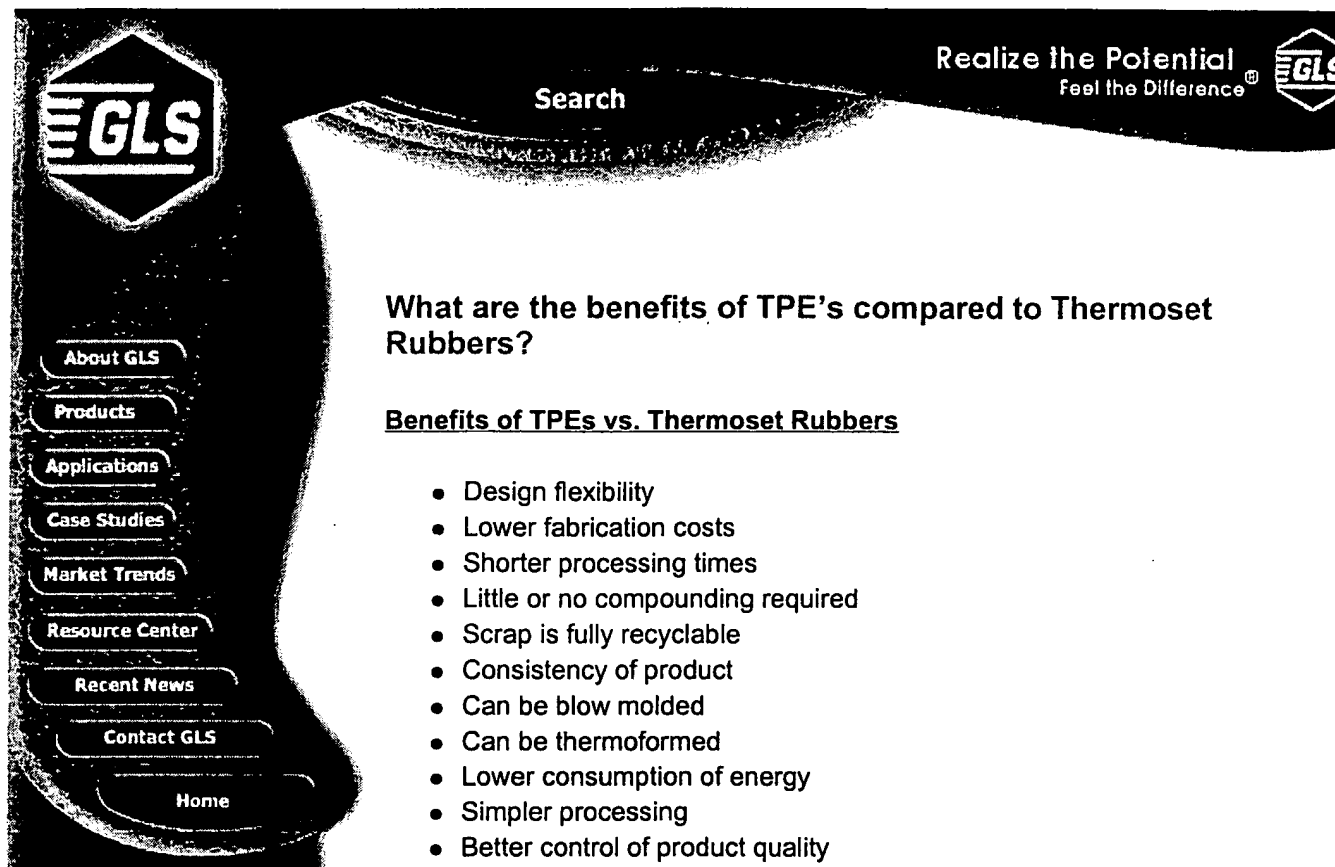
The new polyolefin plastomers (POP's) and elastomers (POE's) are

essentially very low molecular weight, linear low density polyethylenes (VLMW-LLDPE). A product of advancements in polymerization catalyst technology, these materials were originally slated for use in improved flexible packaging films. Recently, these more flexible polyethylenes have seen uses as low-cost rubber replacements for some non-demanding molded goods applications: those that will not be exposed to extremes in temperatures, pressures, loads or stress environments. In molded goods, these new materials are being used where "some" degree of flexibility or tactile feel is desired. They are not true elastomers!

*top* ▲

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**What are the benefits of TPE's compared to Thermoset Rubbers?**


**Benefits of TPEs vs. Thermoset Rubbers**

- Design flexibility
- Lower fabrication costs
- Shorter processing times
- Little or no compounding required
- Scrap is fully recyclable
- Consistency of product
- Can be blow molded
- Can be thermoformed
- Lower consumption of energy
- Simpler processing
- Better control of product quality
- Broader range in product density
- Lower per-piece finished part cost
- More environmentally friendly

[top ▲](#)


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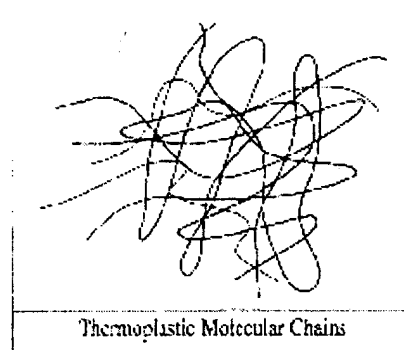
## What is the difference between thermoplastic and thermoset elastomers?

Elastomers are commonly grouped into two major categories:

- Thermoplastic
- Thermoset

### Structure

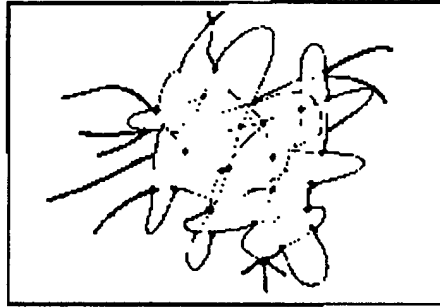
Thermoplastic Elastomers are materials that repeatedly soften/melt when heated and harden when cooled. Most thermoplastics are soluble in specific solvents and can burn to some degree. Softening/melt temperatures vary with polymer type and grade. Because of thermoplastics' heat/shear sensitivity, care must be taken to avoid degrading, decomposing, or igniting the material.



Most thermoplastic molecular chains can be thought of as independent, intertwined strings resembling spaghetti (see the figure to right). When heated, the individual chains slip, causing plastic flow. When cooled, the chains of atoms and molecules are once again held firmly. When subsequently heated, the chains slip again. There are practical limitations to the number of heating/ cooling cycles to which thermoplastics can be subjected before appearance and mechanical properties are affected.

Thermoset Elastomers undergo a chemical change during processing to become permanently insoluble and infusible. It is this chemical cross-linking that is the principal difference between thermoset and thermoplastic systems. Natural and synthetic rubbers such as latex, nitrile, millable polyurethane, silicone, butyl, and neoprene, which attain their properties through a process known as vulcanization, are typical thermoset elastomers.

As can be seen by the diagram below, when thermosets are cured or hardened, cross-links are formed between adjacent molecules, resulting in a complex, interconnected network. These cross bonds prevent the individual chains from slipping, thus preventing plastic flow when heat is added. If excessive heat is added to the thermoset elastomer after the cross-linking is complete, the polymer is degraded rather than melted. This behavior is somewhat similar to an egg when it is cooked: further heating does not return the egg to its liquid state, it only burns.



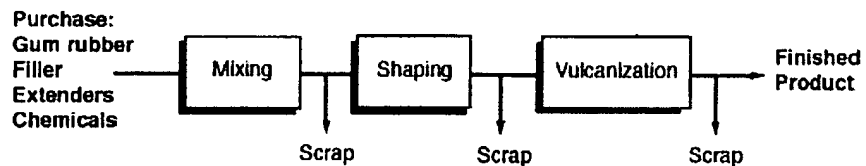
### How to define processing

It is the capability to repeatedly process thermoplastic elastomers that supplies a major benefit over thermoset rubber. Key processing differences are captured in the diagrams below.

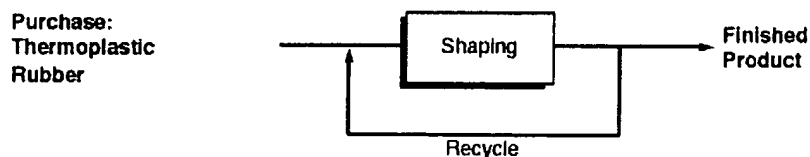
Variable	TPE	Thermoset Rubber
Fabrication	Rapid (seconds)	Slow (minutes)
Scrap	Reusable	High Percentage waste
Curing Agents	None	Required
Machinery	Conventional Thermoplastic Equipment	Special Vulcanizing Equipment
Additives	Minimal or None	Numerous Processing Aids
Design Optimization	Unlimited	Limited
Remold Parts	Yes	Unlikely
Heat Seal	Yes	No

Source: Robert Eller Associates

### Conventional Rubber Products



### Thermoplastic Rubber Products





[top](#) ▲

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**Polypropylene Cast Film: A variety of solutions**

Basell offers a wide range of PP materials for the production of highly transparent and glossy cast film, with grade ranges including standard random and homopolymers as well as grades from Basell's latest catalyst and polymerisation technologies. Among the materials in the latter category are Basell's new *Clyrell* random copolymers and *Adstif* high crystallinity homopolymers. Also available are other speciality polymers that facilitate the development of new, unique properties in terms of softness (*Adflex* resins) and sealing (*Adsyf* resins). The wide range of polymers allows the production of tailored cast film for a broad array of applications. All grades are available in a variety of additive packages from barefoot to slip and anti-block combinations. By blending a variety of PP types, resin properties can be adapted according to the final application requirements.

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## Bibliography

**Chemical Economics Handbook** - The following CEH reports contain additional information that is pertinent to the subject of this report:

- Elastomers Overview
- Ethylene-Propylene Elastomers
- Polypropylene Resins

**Other References** - The following list of additional references is suggested for supplemental reading:

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## THERMOPLASTIC POLYOLEFIN (TPO)



The polymer or plastic produced for Royal Tuff- Ply is properly referred to as a Thermoplastic Polyolefin or "TPO".

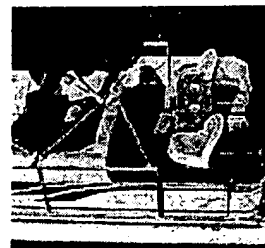
As a next generation to EPDM rubber roofing, Alpha Systems, Inc.

introduced the Royal Tuff-Ply roofing/flooring material to the RV and Marine industries in 1994. The TPO formulation being used for Royal Tuff-Ply is resistant to algae, mold, fungus, or other biological agents. Therefore, the sheet can easily be cleaned to an appearance very near its original state through the use of common cleaning agents, i.e. Murphy's Oil Soap™, and remain unaffected due to TPO's very good chemical resistance.

TPO uses special organic chemical additives for UV protection of the polymer. The chemical additives used in TPO for protection from UV light are not self-sacrificing rather they operate in a regenerative fashion as they interfere with the degradation reactions that occur from UV light exposure.

The base TPO being used to create the Royal Tuff-Ply is the very same type and quality of TPO being used by commercial roofing companies. The tear and puncture resistance of TPO sheets are typically 20-50% higher than those of EPDM rubber sheets. The repair techniques for Royal Tuff-Ply are very "environmentally friendly". TPO polymers being "plastics" can be repaired through a heat welding process.

The chemistry of the TPO allows for no chalk residue or degradation of the membrane through its useful life. TPO membranes are actually non-skid when wet and therefore are very friendly to the deck and pontoon boat industries as floor coverings.



Titanium dioxide is used in TPO for the purpose of giving finished products a very white color. TPO has special organic chemical additives for UV protection of the polymer, therefore, they do not need to use extremely high levels of TiO<sub>2</sub> for protection of the polymer.

TPO membranes are the result of the latest advances in the field of

plastic technology and will provide many years of reliable performance in the industries they serve.

**link to: Cleaning and Maintaing the Royal Tuff-Ply™ Roof**

Alpha Systems, Inc. 5120 Beck Drive Elkhart, IN 46516  
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